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ABSTRACT

A study examined hierarchical relationships among three developmental components of reading ability in grades 1 through 3. It was predicted that semantic skills develop initially, followed by letter identification skills, phonological skills, and visual skills. Reading ability was assessed with a word identification task. The semantic components of reading were assessed with word definition tasks, phonological skills were measured with rhyming tasks, and visual graphic skills were tapped with a letter naming task. Hierarchical relationships among performances on tasks were examined as they characterize the acquisition of reading for beginning readers. Children were tested individually, and all responses were recorded as pass or fail. The results showed that children performed most accurately and correctly on verbal definition and picture tasks, scoring at ceiling levels in all grades. Their performance was successively less accurate on letter identification, rhyming production, and reading production, particularly for first and second grade students. The results suggest that most beginning readers acquire reading skills in a hierarchical order most of the time. The findings also show the relevance of visual graphics and phonological skills to reading development--most children who consistently failed visual graphics and phonolgoical tasks tended to experience difficulty in oral reading performance and to read below grade level in class. (HTH)

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Hierarchical Relationships Among Components of Reading Abilities of Beginning Readers

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Hierarchical Relationships among Components of Reading Abilities of Beginning Readers

This study examined hierarchical relationships among three developmental components of reading ability: i.e., (a) semantic skills, (b) phonological skills, and (c) visual graphic skills. Reading ability was assessed with a word identification task. The semantic components of reading were assessed with word definition tasks; phonological skills were measured with rhyming tasks; and visual graphic skills were taped with a letter naming task. Hierarchical relationships among performance on the task were examined as they characterize the acquisition of reading for beginning readers in grades 1 through 3.

Several models have been formulated to account for cognitive processes involved in reading (Mason 1977, LaBerge and Samuels 1974). The best articulated model is that proposed by LaBerge and Samuels (1974), who conceptualized reading as a hierarchical sequence of cognitive decoding processes through which a child links graphic symbols to phonemic codes, phonemic codes to semantic codes, and so on. Although they are complex and varied, the decoding processes may be categorized under semantic, phonological, and visual graphic types of acts. The model implies that mature reading skill involves a hierarchical sequence through which children proceed as they perform each act successively. In their words, these researchers attempted to "present a model of the reading process which describes the main

stages involved in transforming written patterns into meanings and prelates the attention mechanism to processing at each of these stages" (p. 293).

LaBerge and Samuels may be accurate in their contention that their several subskills and stages are involved reading performance. However, these theorists do not account satisfactorily for how the skills are actually developed. The concepts of decoding and processing, stages, alone are insufficient to explain skill development, since ordinal relationships that characterize the acquisition of skills that are necessary for decoding, e.g., letter naming, rhyming have not been satisfactorily established. In order to determine how reading skills develop, a link must be established between the ordinal development of skill patterns and of cognitive processes that seemingly underlie reading ability.

Skill Theory

Fischer (1980) offered a theoretical framework for explaining how skills are a tually built, diversified, and generalized. Fischer and his colleagues constructed a theory of cognitive development, called skill theory, which attempted to explain and predict "developmental sequences and synchronizes in any domain [such as reading] at any point in development, by integrating behavioral and cognitive developmental concepts" (p. 277). Cognitive development was described "as the construction of hierarchically ordered collections of specific skills" (p. 477).

Fischer summarizes his theory in the following:

> Skill theory provides an abstract representation of the structures of skills that emerge in cognitive development,

> together with a set of transformational rules that relate these structures to each other. The structures and transformational rules comprise a tool for explaining and predicting the developmental sequences and synchronies from birth to adulthood. . .
>
> Here is a brief overview: Skills develop step by step through a series of 10 hierarchical levels divided into three tiers. The tiers specify skills of vastly different types: sensory-motor skills, representational skills, and abstract skills. The levels specify skills of gradually increasing complexity, with a skill at one level built directly on skills from the preceding level. Each level is characterized by a reasonably well defined structure that indicates the kinds of behaviors that a person (child or adult) can control at that level. The skills at each level are constructed by a person acting on the environment. S/he performs several actions induced by a specific environmental circumstance, and the way these actions occur in that circumstance provokes her/him to combine the actions: The person thus combines and differentiates skills from one level to form skills at the next higher level. The movement from one level to the next occurs in many micro-developmental steps specified by a series of transformation rules. Notice the skill develops through levels, not stages: Development is relatively continuous and gradual, and the person is never at the same level for all skills. The development of skills must be induced by the environment, and only the skills induced most consistently will typically be at the the highest level that individual is capable of. Uneveness in development is therefore the rule, not exception. The level of skills that are strongly induced by the environment is limited, however, by the highest level of which the person is capable. As the individual develops, this highest level increases, and so s/he can be induced to extend these skills to the new, higher level. (pp. 479-480).

Fischer's skill theory may be applied readily to beginning reading. According to skill theory, the child gradually builds reading skills as a result of performing reading activities encouraged by the environment (e.g., seeing letters and words, hearing letter names and sounds, seeing objects and hearing them named). Specific environmental circumstances (such as play, experimentation, and school activities) provoke the child to combine, and later, to differentiate reading skills to eventually form skills at the next higher level.

In addition, skill theory may be used to construct a developmental account in the form of a task analysis or schema. Fischer's skill theory provides mechanisms for the development of skills in the form of transformation rules, which are useful for explaining how skills are elaborated, modified, and differentiated.

Comparison of LaBerge and Samuel's and Fischer's Models

The theoretical viewpoints of LaBerge and Samuels (1974) and Fischer (1980) are similar in a number of ways. Both theories consider reading to be a cognitive process involving a hierarchical arrangement of stages or levels. Both theories provide for multiple routes of processing for any one cognitive task. Both acknowledge the importance of practice in influencing the degree to which a concept is learned.

However, there are also noteworthy differences between the two frameworks. On the one hand, LaBerge and Samuels established a plausible framework to define basic cognitive processes involved in reading through identification of semantic, phonological and visual graphic catgories. On the other hand, Fischer provided a framework for explaining how these processes are involved in the construction, i.e., development, of reading skills. The consolidation of these two theories may consequently be used to construct a developmental model or schema of word reading skills (Knight, 1982). This schema is presented in Figure 1.

This model was constructed to characterize the hierarchical sequence of behaviors exhibited by a child when learning to read. As such, the prior mastery of certain entering skills was assumed. Among

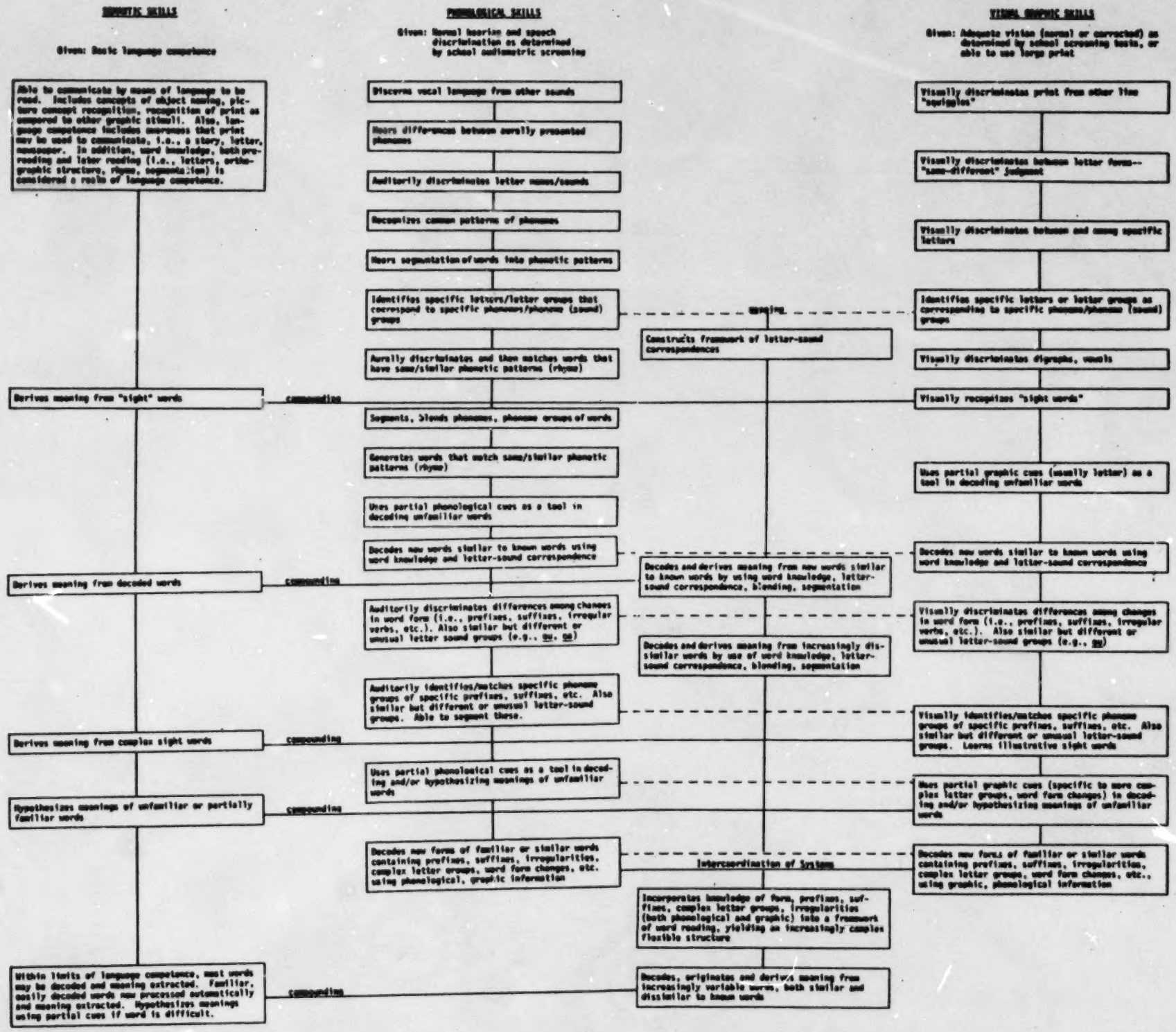

SEMANTIC SKILLS
Given: Basic language competence
Able to communicate by means of language to be read. Includes concepts of object naming, picture concept recognition, recognition of print as compared to other graphic stimuli. Also, language competence includes awareness that print may be used to communicate, i.e., a story, letter, newspaper. In addition, word knowledge, both pre-reading and later reading (i.e., letters, orthographic structure, rhyme, segmentation) is considered a realm of language competence.
Derives meaning from "sight" words
Derives meaning from decoded words
Derives meaning from complex sight words
Hypothesizes meanings of unfamiliar or partially familiar words
Within limits of language competence, most words may be decoded and meaning extracted. Familiar, easily decoded words now processed automatically and meaning extracted. Hypothesizes meanings using partial cues if word is difficult.
compounding
PHONOLOGICAL SKILLS
Given: Normal hearing and speech discrimination as determined by school audiometric screening
Discerns vocal language from other sounds
Hears differences between aurally presented phonemes
Auditorily discriminates letter names/sounds
Recognizes common patterns of phonemes
Hears segmentation of words into phonetic patterns
Identifies specific letters/letter groups that correspond to specific phonemes/phoneme (sound) groups
Aurally discriminates and then matches words that have same/similar phonetic patterns (rhyme)
Segments, blends phonemes, phoneme groups of words
Generates words that match same/similar phonetic patterns (rhyme)
Uses partial phonological cues as a tool in decoding unfamiliar words
Decodes new words similar to known words using word knowledge and letter-sound correspondence
Auditorily discriminates differences among changes in word form (i.e., prefixes, suffixes, irregular verbs, etc.). Also similar but different or unusual letter sound groups (e.g., ou, oo)
Auditorily identifies/matches specific phoneme groups of specific prefixes, suffixes, etc. Also similar but different or unusual letter-sound groups. Able to segment these.
Uses partial phonological cues as a tool in decoding and/or hypothesizing meanings of unfamiliar words
Decodes new forms of familiar or similar words containing prefixes, suffixes, irregularities, complex letter groups, word form changes, etc. using phonological, graphic information
compounding
mapping
Constructs framework of letter-sound correspondences
Decodes and derives meaning from new words similar to known words by using word knowledge, letter-sound correspondence, blending, segmentation
Decodes and derives meaning from increasingly dissimilar words by use of word knowledge, letter-sound correspondence, blending, segmentation
Incorporates knowledge of form, prefixes, suffixes, complex letter groups, irregularities (both phonological and graphic) into a framework of word reading, yielding an increasingly complex flexible structure
Decodes, originates and derives meaning from increasingly variable words, both similar and dissimilar to known words
VISUAL GRAPHIC SKILLS
Given: Adequate vision (normal or corrected) as determined by school screening tests, or able to use large print
Visually discriminates print from other line "squiggles"
Visually discriminates between letter forms--"same-different" judgment
Visually discriminates between and among specific letters
Identifies specific letters or letter groups as corresponding to specific phoneme/phoneme (sound) groups
Visually discriminates digraphs, vowels
Visually recognizes "sight words"
Uses partial graphic cues (usually letter) as a tool in decoding unfamiliar words
Decodes new words similar to known words using word knowledge and letter-sound correspondence
Visually discriminates differences among changes in word form (i.e., prefixes, suffixes, irregular verbs, etc.). Also similar but different or unusual letter-sound groups (e.g., ou)
Visually identifies/matches specific phoneme groups of specific prefixes, suffixes, etc. Also similar but different or unusual letter-sound groups. Learns illustrative sight words
Uses partial graphic cues (specific to more complex letter groups, word form changes) in decoding and/or hypothesizing meanings of unfamiliar words
Decodes new forms of familiar or similar words containing prefixes, suffixes, irregularities, complex letter groups, word form changes, etc., using graphic, phonological information
Intercoordination of Systems

Figure 1. A Schema of Word Reading Skills

these are: (a) the rudiments of language such as vocabulary and sentence structure, et., (b) the awareness that print is found in books, magazines, newspapers, signs, etc., and (c) the ability to differentiate printing and writing from other kinds of graphic material--e.g., pictures, designs (Lavine, cited in Gibson & Levin, 1975). Children also are assumed to have normal hearing and vision (corrected, if necessary), and also to have had access to printed material, television, and other forms of media. If these assumptions do not hold for a child, the model as presented is likely not valid and would necessitate revision. Fischer (1980) asserted that deviant circumstances are expressed in different paths of skill acquisition, although the end result of different paths may be essentially equivalent. The presented conceptualization is designed to be a basic blueprint of word reading skills which allows prediction or modification according to specific circumstances.

Using the Model

This model of work reading skills (Figure 1) illustrates one way to trace the development of a particular reading skills and also to identify subskills subsumed under that skills. Not all subskills listed in the model are necessary for development of general ready skills, but each may influence reading skills of some individuals. The tracing of skill development by means of the model may be illustrated by use of letter naming skills. This skill is comprised of subskills from all three components, i.e., semantic, phonological, and visual graphic. The child must be aware that graphic forms have names as do other objects in the environment, and that specific

letters have specific names (semantic skills). In addition, the child must be able to hear and discriminate between and among letter names (phonological skills). The child also must recognize print and visually discriminate among letter forms (visual graphic skills). Finally, the child must interrelate these skills through mapping (Fischer, 1980) to establish a relation between three sets of skills--semantic, phonological, and visual graphic. The three systems are then intercoordinated (Fischer, 1980) to form new skills at the next higher level, resulting in a framework of sound-letter correspondences, each letter having a specific name. The tracing of skill development may be similarly done for rhyme tasks, actual word recognition tasks, or others, as depicted in Figure 1.

Testing the Model

Studies of developmental processes by Watson, Watson and Fischer, Berenthal and Fischer, and Hand (cited in Fischer, 1980) are supportive of skill theory. However, no studies utilizing skill theory have investigated a cognitive process as complex as that of learning to read. It is expected that the conceptual framework (Figure 1), based on LeBerge and Samuels' writings in conjunction with Fischer's skill-building mechanism will provide a way to accurately describe and explain the word reading process. If the task analysis and the model do accurately represent the sequence of reading acquisition, then prediction of skill hierarchies for various levels of development may be possible. Due to varying task demands and experiential factors, variation in children's performance from word to word is expected to occur (Fischer, 1980), but the overall pattern of acquisition of skills should be parallel.

Based on the aforementioned rationale and resulting construction of a model of work reading skills, the following hypothesis may be postulated:

When learning to read, i.e., to decode words, beginning readers develop a predictable sequence of cognitive skills arranged in hierarchical levels, which is expressed in a particular hierarchical pattern of skill building. This pattern of skill building includes semantic, phonological, and visual-graphic component skills which are incorporated in the construction of reading skill. Semantic skills (e.g., as evidenced by matching spoken words to pictures or by verbal definitions) develop initially, followed by (1) capacities to identify individual letters, (2) to differentiate and reproduce phonological patterns (e.g., as evidenced by rhyming), (3) to recognize visual-graphic sequences and their interrelationships, and ultimately, (4) to synthesize these skills to produce rhyme and to read words without prompting.

Skills acquired earlier in the pattern will manifest themselves by higher success rates on tasks that include these skills, i.e., for children who have not yet mastered the more advanced skills. Furthermore, ordinal relationships will be revealed by patterns of performance on the tasks which indicate that more advanced (higher order) skills cannot be performed unless lower order skills have been mastered.

METHOD

Criteria for Selection of the Measures

In order to test the word reading model appropriately, the measures used must conform to several specifications. First, measures must accurately reflect the environmental circumstances the child experiences in the natural environment (Fischer, 1980). Thus, tasks must be similar to those taught or practiced in the school, home, or media (such as "Sesame Street"). Second, measures must be appropriate to the level of the beginning reading child, so the child may use and manipulate the tasks upon encountering them. Thus, the tasks must be a logical extension of the conceptual framework they are intended to test, and have a logically supportable breakdown of skills (i.e., task analysis) appropriate to the framework. Tasks must also represent--and therefore assess--semantic, phonological and visual-graphic components described by LaBerge and Samuels.

Seven Tasks

Though other tasks might conform to the criteria listed above, seven tasks were selected which conform to the criteria for this study and are listed below, followed by the rationale for selection. These tasks are:

1. Picture Definition (recognition)--when a word is presented orally, the child is asked to select a picture illustrating the word's meaning.

2. Verbal Definition (production)--the child is asked to produce a verbal definition or indicate the meaning of a word.
3. Letter Identification (production)--the child names the letters comprising a word.
4. Rhyming Recognition--the child selects from three orally presented words one which rhymes with a stimulus word.
5. Rhyming Production--the child verbally produces, without prompts, a word that rhymes with a stimulus word.
6. Reading Recognition--the child matches a printed word to an appropriate picture depicting its meaning.
7. Reading Production--the child orally reads a word without prompting.

Definitional tasks, i.e., verbal definition and picture definition, were selected to establish language competence with reference to the stimulus words used. While language competence has been demonstrated to be well intact by the time the child enters school (Gibson & Levin, 1975) and such language competence hence precedes reading (Ruddell, 1976; Venezky, 1977), definitional tasks were employed in this study to assess directly the level of lexical and semantic development. The picture definition task was utilized if the child had difficulty in producing a verbal definition of the word.

A pilot study was conducted to assess appropriateness of stimulus words. Consequently, 16 words were selected that proved to be easily understood, readily defined, and rhymed by the children. These words were:

boat	fish	nest	letter
frog	train	shell	dress
cake	string	rock	cherry
tree	bread	toys	thought

Three simple, black-and-white line drawings were prepared for use with each stimulus word: one portraying the word concept, and two pictures portraying objects other than the word concept. In addition, three words appropriate to each stimulus word were selected for the 'Rhyme Recognition' condition.

Procedure

Children were taken from their classrooms and tested individually in one session. Each child was shown into a quiet room and seated next to the examiner. The child and examiner engaged in a few minutes of conversation to establish rapport and to test the child's concepts of rhyming and defining words. The experimenter asked the child to listen to a sample word and then to say a word that sounded the same at the end, and/or rhymed with it. The experimenter demonstrated rhyming, if necessary. Similarly, she asked the child to tell what the word meant. If the child had difficulty, the experimenter demonstrated rhyming a second time.

Order of testing. Each child was presented each stimulus word (printed on a card), and asked "What is this word?" Responses were recorded verbatim and scored as correct or incorrect, as well as written down verbatim. If the child read the stimulus word correctly, s/he was asked "What does this word mean?" If the child was able to

define the concept, i.e., for "red" an adequate response was "a color, like an apple," then the child was asked, "Can you think of a word that rhymes with this word?" (referring to the stimulus word). Thus far, the stimulus word was never actually spoken by the experimenter. The child was required to emit his/her own correct response and base definition and rhyme on this word.

For each word, if the child was unsuccessful on any of the tasks, a sequence of additional tasks was presented, contingent on the particular failed response. If the child did not read the stimulus word correctly, then s/he was asked to match the printed word with a picture illustrating the word concept from a group of four other pictures. The child was asked, "Can you match the picture that goes with this word?" Again, the stimulus word was not spoken by the experimenter. If the child was unable to match the word with picture, the expermenter referred to the rhyme recognition words listed in Appendix C. The experimenter then asked the child to, "Listen carefully. Which of these words rhymes with (stimulus word), ____, ____, or____?" The appropriate rhyme prompt words were then read to the child. This test condition is the only time the child was actually orally presented with the word by the experimenter.

After the rhyme conditions, the child was asked to name the letters in the printed word, asking "What are the letters in this word?" This process was followed for each word. No responses were praised or corrected. However, the experimenter encouraged each child to "do the best job you can." Figure 2 illustrates the progression of the testing process.

For each word:

Present word card--

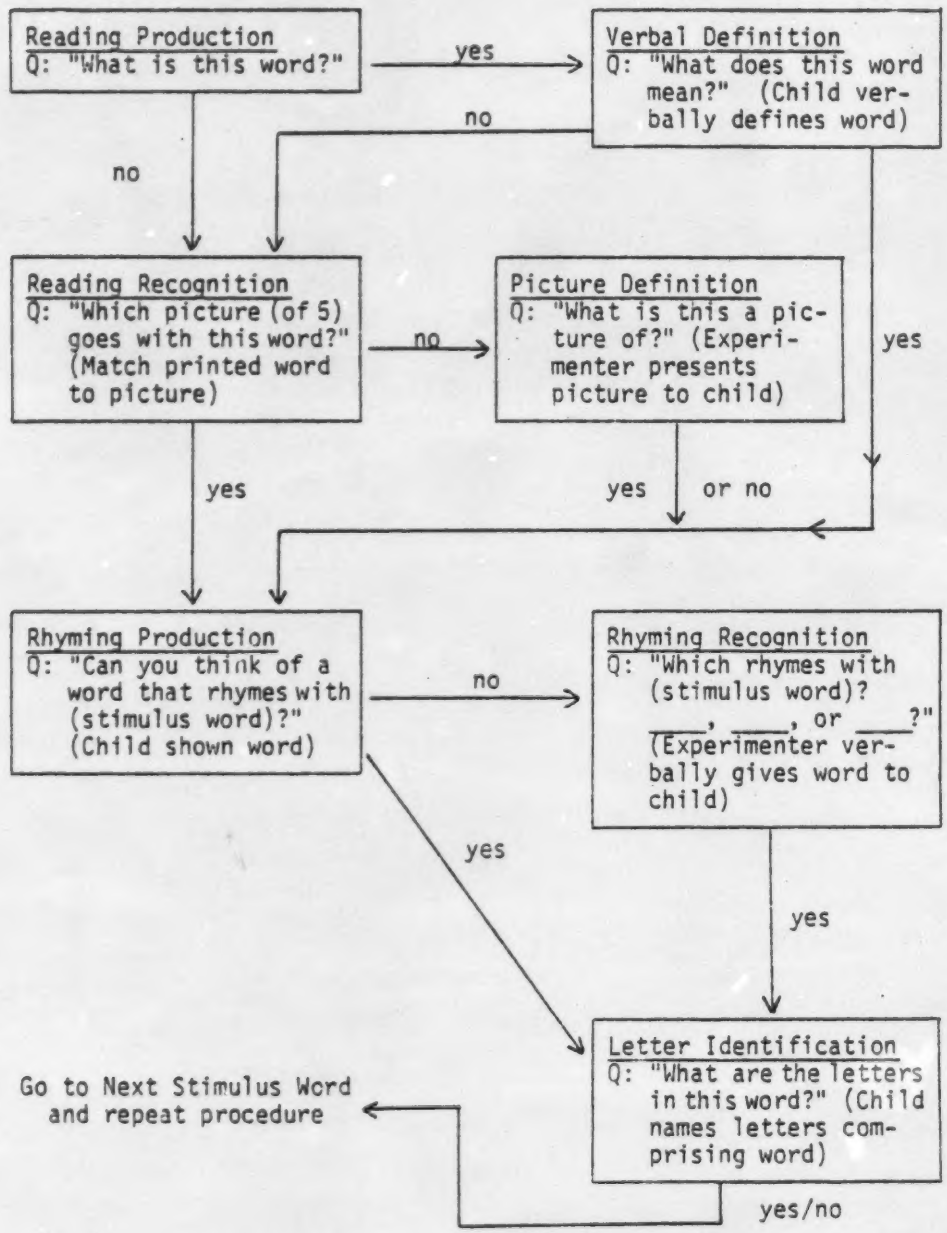

Reading Production
Q: "What is this word?"
yes
Verbal Definition
Q: "What does this word mean?" (Child verbally defines word)
no
no
Reading Recognition
Q: "Which picture (of 5) goes with this word?" (Match printed word to picture)
no
Picture Definition
Q: "What is this a picture of?" (Experimenter presents picture to child)
yes
yes
yes or no
Rhyming Production
Q: "Can you think of a word that rhymes with (stimulus word)?" (Child shown word)
no
Rhyming Recognition
Q: "Which rhymes with (stimulus word)? ____, ____, or ____?" (Experimenter verbally gives word to child)
yes
yes
Letter Identification
Q: "What are the letters in this word?" (Child names letters comprising word)
yes/no
Go to Next Stimulus Word and repeat procedure

Figure 2. Flow chart of the testing process

Scoring. All responses were recorded as pass (1) or fail (0). If a child responded correctly to any task, the failure contingent task was not given, but was scored as automatically passed.

RESULTS

Comparison of Task Difficulty

Means and standard deviations describing children's ages and their teacher-assigned reading levels, are presented in Table 1. The mean ages and reading levels generally corresponded with the children's grade levels. Table 2 compares means and standard deviations on the seven tasks for all first, second, and third graders. The children's success rates on each subtask indicate, in general, which subtasks were relatively easy and which were relatively difficult for beginning readers. Table 2 shows that children performed most accurately and correctly on Verbal Definition and Picture Definition tasks. In fact, children performed equally well on these two tasks, scoring at ceiling levels in all grades. Since performance for all children was "perfect" on these tasks, the data were combined in Table 2. Children's performance was successively less accurate on Letter Identification, Rhyming Recognition, Reading Recognition, Rhyming Production, and Reading Production. This pattern was revealed most clearly for first- and second-grade children. Most third graders scored at the ceiling on all of the tasks. Thus, the order of task difficulty is consistent with the pattern of skill acquisition predicted by H_1.

Table 1

Chronological Ages and Teacher Assigned Reading Levels of First-, Second-, and Third-Grade Children

		Grade		
		1 N = 38	2 N = 43	3 N = 39
Chronological Age	$\bar{X}$	6.6	7.5	8.4
	SD	.4	.4	.4
Group Reading Level[a]	$\bar{X}$	1.0	1.7	2.9
	SD	.5	.6	.6

[a]Based on teachers' ratings and placement in reading groups.

Table 2

Mean Scores and Standard Deviations of First, Second, and Third Graders' Performance on Item Subtasks

Subtask	Grade	Mean	SD
Verbal Definition/Picture Definition	1 (N = 38)	16.0[a]	0.0
Ability to recognize a picture of and verbally communicate an appropriate meaning of the word item	2 (N = 43)	16.0	0.0
	3 (N = 39)	16.0	0.0
Letter Identification	1	14.8	2.5
Ability to correctly name the letters comprising a word	2	15.8	0.6
	3	16.0	0.0
Rhyming (Recognition)	1	14.0	3.3
Ability to correctly select (from a choice of three) a word that rhymes with the word item	2	15.6	1.1
	3	16.0	0.2
Reading (Recognition)	1	13.0	2.7
Ability to correctly match a printed word to an appropriate picture	2	15.7	0.8
	3	15.9	0.2
Rhyming (Production)	1	10.5	5.6
Ability to verbally produce, without assistance, a word that rhymes with the word item	2	13.6	2.8
	3	15.0	1.1
Reading (Production)	1	6.1	5.2
Ability to verbally read a word without assistance	2	14.3	2.3
	3	15.6	1.2

[a]Maximum score possible for all tasks is 16.

Order Analysis

Although the data describing task difficulty provide a general indication of the level of component skills of the beginning readers in this study, they provide only indirect evidence that performance on the subtasks is hierarchical, since successful performance on a more difficult task might or might not be related to, or contingent upon, skills needed to pass an easier task. A recently developed statistical tool that detects such contingencies is order analysis (Krus, Bart, Airasian, 1975).

Order analysis provided a means for determining dominance relations among variables. This technique computes within and between item variances so as to reveal contingencies among and differences between items. The analysis describes a hierarchical order and relationships among the items which can be portrayed graphically in a "dendrogram" (Krus & Blackman, 1980). Thus, in addition to finding significant differences between items, hierarchical relationships among items may be explored through the resulting dendrogram.

Consequently, in order to test for and describe hierarchical patterns an order analysis was computed on children's responses to the seven experimental subtasks (i.e., Verbal Definition, Picture Definition, Letter Identification, Rhyme Recognition, Reading Recognition, Rhyme Production, and Reading Production). Following the recommendation of Krus (1976), a probability level of .84 was selected to determine whether a pair of items was hierarchically dependent, equivalent, or independent. Hence, the probability of erroneously identifying an ordinal relationship that was actually due to chance

was .16. This level was selected as optimally sensitive to complex hierarchical relationships among variables.

Thus, through order analysis, a hierarchy of relationships may be constructed, the magnitude of relationships between variables specified and the nature of relationships (dominant, equivalent, independent) determined. The following results of order analyses are presented to describe the performance of beginning readers.

Dendrograms. The dendrogram describing the overall performance (on all stimulus words combined) is presented in Figure 3, along with a conceptually constructed model of a dendrogram based on the hypthesized pattern of performance on the seven subtasks. The dendrograms represent hierarchical relationships among the seven subtasks. The hypothesized dendrogram predicted that performance on the semantic tasks, Picture Definition and Verbal Definition, would be basic to performance on all others. Performance on semantic tasks was expected to be prerequisite to Letter Identification, which, in turn, was predicted to be a necessary condition for both Reading Recognition and Rhyming Recognition. However, skills underlying success on the recognition tasks were expected to develop independently of one another. Rhyming Recognition was predicted to be prerequisite to Rhyming Production but independent of Reading Recognition. Both Reading Recognition and Rhyming Production were expected to be necessary conditions for Reading Production, i.e., oral reading of the stimulus word.

Generally, the dendrogram based upon children's performances indicated that Verbal Definition and Picture Definition tasks were

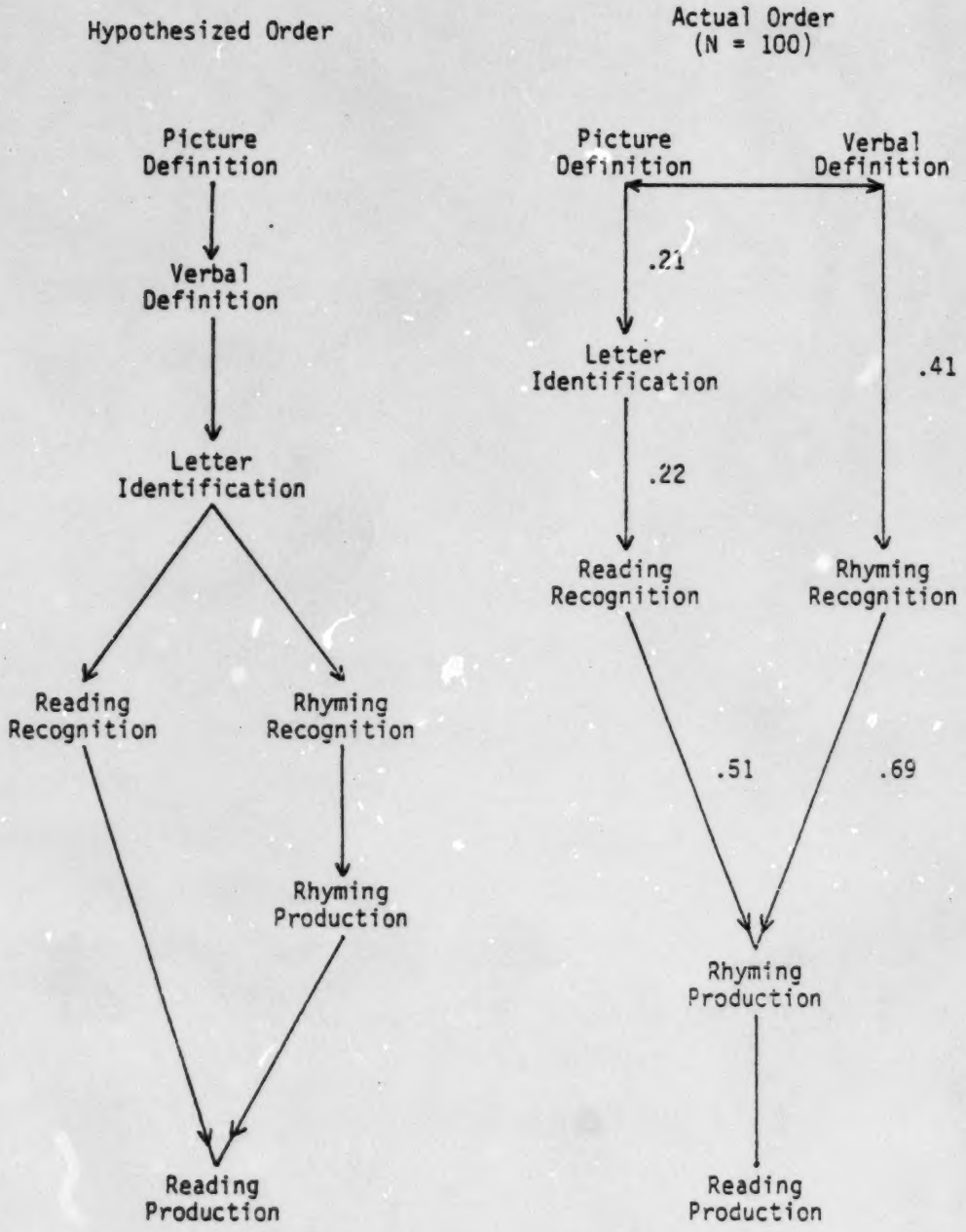


Figure 3. Hypothesized and actual orderings of seven subtasks tested.

basic to all other with neither task prerequisite to the other. Hence, these semantic tasks held essentially equivalent levels in the performance hierarchy. Equivalence is indicated by representation on the same horizontal level. Letter Identification held the next higher level and was dominated by Picture Definition, but not Verbal Definition. The Rhyming and Reading Recognition tasks occurred at more advanced levels on the dendrogram and were essentially independent of one another. However, both Reading and Rhyming Recognition tasks were necessary for successful performance on Rhyming Production and Reading Production tasks.

Thus, the dendrograms of hypothesized and actual performances were similar, with two exceptions. First, Letter Identification had been expected to be prerequisite to both the Reading Recognition and Rhyming Recognition tasks because a reader presumably must be able to recognize letters before s/he can produce a sound that matches a printed word. In actuality, Letter Identification was dominant to Reading Recognition but was independent of Rhyming Recognition. Secondly, Rhyming Recognition had been expected to be dominant to Rhyming Production with Reading Recognition being independent of Rhyme Production. In fact, Reading Recognition and Rhyming Recognition were both found to dominate Rhyming Production.

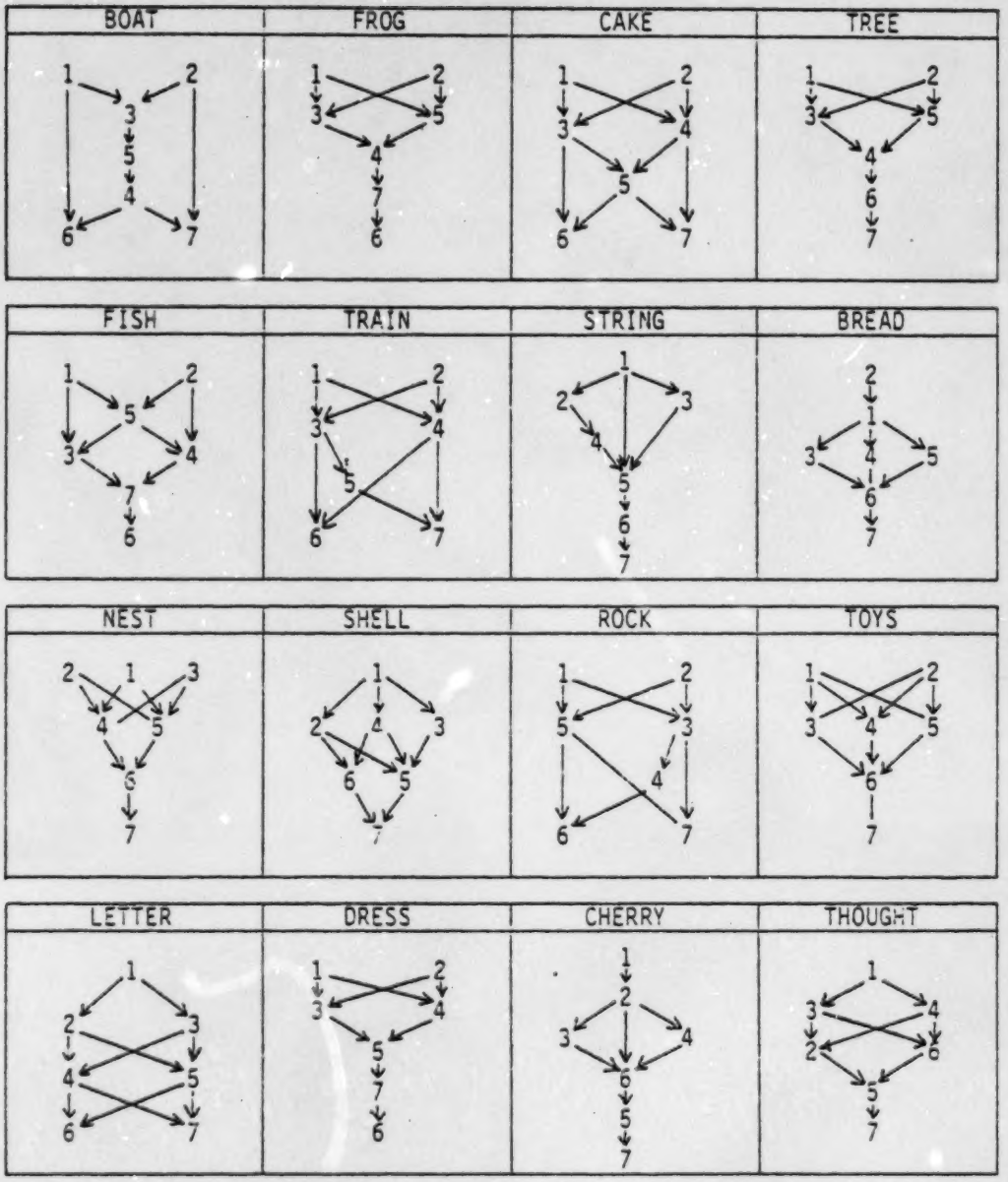
Hence, the hierarchy revealed by the order analyses indicated that Verbal Definition is necessary for successful performance on Letter Identification, and the Rhyming and Reading Recognition tasks. In turn, success on these tasks appears to be a prerequisite for success on the Rhyming and Reading Production tasks. Additionally, the magnitude, i.e., strength or weakness of relationships is indicated on

the performance dendrogram by means of the numerical proportions and length of lines connecting related variables. The proportions are based on a unit of one which is the approximate height of a vertical line drawn from the top of the dendrogram to the bottom. Consequently, an estimate of the degree of relationships between these tasks, and in comparison to other tasks may be made.

Figure 4 presents separate dendrograms for each of the stimulus words. The tasks are coded by number in approximate correspondence with the hypothesized hierarchy. For example, the hierarchy generated for the word 'BOAT' presents Verbal Definition, Picture Definition, and Letter Identification as corresponding to the proposed hierarchy. In this case, however, Reading Recognition is prerequisite to Rhyming Recognition which is, in turn, dominant to both Rhyming Production and Reading Production tasks. In the case of 'BOAT,' both production tasks were independent of one another. In this manner, children's performance on each word may be similarly compared with the predicted hierarchy.

While the actual hierarchical relationships were shown to vary from word to word, certain consistent patterns were revealed for virtually all stimulus words. Specifically, semantic tasks consistently fell at the most basic levels of hierarchies. Letter Identification tasks varied somewhat, but they always were prerequisite to the Rhyming and Reading Production tasks.

In addition, the same task may be compared across words as well. For example, Letter Identification dominated Reading Recognition in 10 of the 16 word items. The reverse order occurred only once. the tasks were parallel on the other five word items. Rhyming Recognition



Note. 1 = Verbal Definition; 2 = Picture Definition; 3 = Letter Identification; 4 = Rhyming Recognition; 5 = Reading Recognition; 6 = Rhyming Production; 7 = Reading Production.

Figure 4. Hierarchical ordering of tasks 1-7 on 16 words for 100 first-, second-, and third-grade children ($\underline{p}$ = .8).

dominated Reading Recognition on six word items, whereas the reverse order was revealed on four items. The two tasks were parallel on five items and independent on one item. Similarly, Rhyming Production dominated Reading Production on eight items and Reading Production dominated Rhyming Production on three tasks. These two tasks were parallel on five items. In this manner, relationships between tasks in a single item may be compared, or those same tasks across items may be examined.

Consequently, the hierarchical ordering of tasks displayed by the dendrograms in Figure 3 was consistent with the rank order of the means presented in Table 2. Both types of data indicated that children performed most successfully on semantic tasks. Children were progressively less successful on Letter Identification, Rhyming Recognition, Reading Recognition, Rhyming Production and Reading Production, respectively. However, the order analyses provided additional information regarding contingent relationships between experimental subtasks. That is, relationships between tasks were determined to be prerequisite.

DISCUSSION

The primary hypothesis of this study was that children when learning to read, acquire reading skills in a predictable sequence which is reflected by a particular hierarchical pattern among children at varying levels of development. Specifically, semantic skills were expected to be a precondition for all other skills, with Letter Identification, Rhyming and Reading Recognition skills assuming successively more advanced levels in the hierarchical pattern. These

skills, in turn, were expected to be prerequisite to oral rhyming and reading of words.

Mean scores on the subtasks indicated that children were most successful on semantic tasks and less successful, respectively, on visual graphic and phonological tasks. Children were least successful on tasks requiring demonstrated intercoordination of these systems (e.g., Rhyming and Reading Production tasks). This order of decreasing levels of success on the tasks was generally consistent with the pattern that was hypothesized as indicative of a particular sequence of acquisition.

Hierarchical Relationships Among Skills

More direct evidence of hierarchical relationships among the skills was provided by Order analyses, which not only indicated which tasks were easy and which were difficult for children, but it also specified contingent relationships of the tasks to one another.

The findings of order analysis corroborated and extended the descriptive findings by hierarchically ordering levels of task success and defining relationships between and among tasks. Specifically, the oral definition and picture-word matching tasks occupied the most basic levels of the hierarchy. This suggests that semantic skills are prerequisites for identification of individual letters, recognition of phonological (i.e., rhyming) and visual graphic (i.e., letter) groups (see Figure 3). Ultimately, all these skills are apparently successively encompassed in capacities to rhyme and read orally. These findings are complementary to Mason's (1980) findings of

hierarchical capabilities in preschoolers. The results of her study suggested a natural hierarchy of skill development in learning to read words. Specifically, according to Mason, children who are competent in language realize (a) that letters are discriminable patterns, (b) that letters provide cues for reading, and (c) that sounds in words are determined by letters.

Although the hierarchical pattern among the tasks in the present study was generally consistent with the hypothesized hierarchy, two aspects of the pattern did diverge from the hypothesis. First, in accordance with the prediction, letter naming was a precondition for Reading Recognition, but contrary to the prediction it was not a precondition for Rhyming Recognition. Apparently, phonological skills, as tested by Rhyming Recognition, were not required in order for a child to utilize a letter to recognize a word. This finding suggests that letter naming and rhyming skills, respectively, initially develop independently of one another and are later utilized in conjunction at more advanced levels of the hierarchy. Second, counter to expectation, both Reading Recognition and Rhyming Recognition tasks were prerequisite to oral rhyming of a word. It had been expected that Rhyming Recognition only would be a precondition for Rhyming Production, i.e., oral rhyming. This finding suggests that integration of visual graphic and phonological skills may be manifested in Rhyming Production ability at an advanced stage of beginning reading rather than the more basic level as originally predicted.

Additional findings that diverged from the hypothesized pattern were found when hierarchies were generated for individual words. The

dendrograms, which portrayed ordinal relationships among the tasks for each word, varied somewhat from the overall hierarchy on the placement or level of one or more tasks. The most variance from word to word was found for the Letter Identification and Recognition tasks, i.e., those that occupied the 'middle' levels of the hierarchy. For example, on Figure 4, Rhyming Recognition appears as prerequisite to Reading Recognition for the word 'cake.' The opposite relation between the tasks is found for the word 'tree.' Such idiosyncratic variation was the rule for the word hierarchies and reflected an inconsistent ordering of skills rather than a uniform one. Thus, the individual variation of word hierarchies was, in some respects, consistent, and in other respects, inconsistent with the hypothesis of a predictable, hierarchical ordering among reading skills. Nevertheless, certain consistencies among task orders are noteworthy for all individual word hierarchies: Semantic tasks fell at basic levels, and Reading and Rhyming Production fell at advanced levels.

The Utility of Skill Theory in Beginning Reading

This study illustrates the utility of Fischer's (1980) skill theory for synthesizing the results of this research and for relating them to an account of the development of complex cognitive skills such as beginning reading. This is so in that skill theory provides a more flexible, dynamic conceptualization of reading than do traditional fixed sequence frameworks (cf., Gough, 1972; Mason, 1977). Consequently, skill theory is better able to describe the complex and hierarchical nature of skill development in that skill theory characterizes developmental structures for the acquisition of

beginning reading skills. In addition, it includes mechanisms, that is, transformation rules, that account for growth and change in skills.

Moreover, by conceptualizing the development of skills through skill theory, and by using order analysis and similar statistical tools, the general order of acquisition and relationships (i.e., contingency, independence) among developing skills could be described more systematically than had been previously possible. For example, order analysis characterized the hierarchical nature of sk[illegible] development by means of specifying the prerequisite development of some skills, i.e., letter identification, as a condition for others, i.e., oral reading. Order analyses of group responses to individual words revealed varying relationships among skills for different words.

Hence, a skills theory conceptualization may be a useful way to conceptualize acquisition of work reading skills. That is, the schema (see Figure 1) developed from Fischer's (1980) skill theory, and the work of LaBerge and Samuels (1974) may also describe, in a general way, the development and transformation of basic reading skills culminating in the oral reading of words. Of course, it is also quite possible that other skill components could be identified and consequently that other task analyses and developmental schemes could be proposed which describe the development of word reading skills more accurately than does the one presented in this paper. The current data provide only general support for the structure presented. Further research is needed to test this conceptualization.

The Assessment of Reading Skill Development

Fischer's conceptualization of beginning reading may be utilized to formulate an account of the acquisition and change of reading skills. Fischer asserted that a theory is of little worth unless accurate assessment and ultimate prediction of the described phenomena are possible. This study did not include longitudinal testing and prediction of learning sequences since data were gathered on only one occasion and no subsequent assessment was done. Further, this research dealt with only the more basic word reading skills such as identification of individual letters comprising a word. More complex topics such as the comprehension of text, and deep and surface structure were not addressed since this study dealt only with individual words. Thus, the ultimate utility of skill theory as an account of reading development can only be determined by additional research on such complex aspects of reading.

The limitations of the present study point to the need for additional research to further test the developmental schema of beginning reading presented in this paper, as well as the conceptualization of reading from a skills theory point of view in general. In retrospect, for example, the present study would have profited by modifying the experimental tasks utilized in testing the children. First, the tasks should have been designed to tap skills more basic than those taught in first grade or even kindergarten, e.g., basic language competence, or differentiation of point from other graphic forms. Consequently, the skills of pre-school children would, of necessity, be sampled. Second, the addition of a "letter

phoneme identification" task would also enhance information gained from the other phonological tasks, Rhyming Recognition and Rhyming Production. Such a task could provide data to elucidate the relationship that visual-graphic skills have to phonological skills. The order analyses of letter-name, letter-sound, and rhyming tasks could be especially helpful in understanding and synthesizing the relationships these skills have to one another and to oral reading of words.

Nevertheless, the results of this study are noteworthy in themselves. First, it was found that most beginning readers acquire reading skills in a hierarchical order most of the time. Second, these findings have shown the relevance of visual graphic and phonological skills to reading development. That is, those children who had sufficient skills to pass visual graphic (e.g., letter naming) and phonological (e.g., rhyming) tasks were found to be functioning adequately in reading skills, both in oral reading performance and attained reading level in the classroom. In contrast, most children who consistently failed visual graphic and phonological tasks tended to experience difficulty in oral reading performance and read below grade level in class.

Finally, a schema of w d reading skills was presented as one way to conceptualize the development of beginning reading. The schema, which was developed from the work of LaBerge and Samuels (1974) and Fischer (1980), may be used as both a theoretical tool and as a basis for developmental reading research. The presented schema implies variable routes toward mastery and performance of a particular reading act, depending upon the difficulty and demand characteristics of a

word. Consequently, the schema implies variations in patterns of word reading subskills, rather than describing simply a single fixed sequence of development. This study does not, however, resolve the question of a sequence of skill acquisition. The ordering of skills has implications for sequence, but does not unequivocally elucidate a sequence of skill acquisition. It is up to future research to determine when specific skills are actually learned. The schema and accompanying methodology may provide a means toward answering the question of sequence and other heretofore perplexing questions about the acquisition of beginning reading skills.

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